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3D MODELLING OF PELVIC FLOOR PRESSURES USING MRI FOR EVALUATING PROLAPSE AND OBSTRUCTED DEFECATION VERSUS ASYMPTOMATIC CONTROLS.

Hypothesis / aims of study

The levator ani muscle is the main muscular support of the pelvic organs and problems with continence and evacuation are thought to be due to levator ani dysfunction. Obstetric trauma is a common cause of faecal incontinence in young women, with childbearing having been shown to be a primary cause of injury to the levator complex, resulting in symptoms of constipation and faecal or urinary incontinence(1).

Present imaging methods for assessing pelvic floor dysfunction provide anatomic data, but not functional assessment during defecation. We present a new method of biomechanical modelling utilising statistical shape analysis techniques(2) to simulate the movements of the pelvic floor. This study aimed to develop a novel method of 3D modelling to assess dynamic functional behaviour of the pelvic musculature under physiologic conditions and strain.

Study design, materials and methods

Ethical approval was granted by the local research ethics committee. A double-ring magnet design with an intervening 56 cm gap with the subject sitting in an anatomically natural position on a bedpan, placed upon a specially constructed MR-compatible chair, between the coils was used. (General Electric SIGNA SPIO 0.5T open scanner (General Electric Company, Milwaukee, WI)). A flexible transmit-receive coil designed and tuned for pelvic floor imaging was attached to the back and seat of the chair.

Symptomatic controls, 12 patients with gynaecological prolapse and 12 patients with obstructed defecation were scanned in a 0.5T open MRI scanner while seated. Scans were performed at rest, pelvic floor squeeze and defecatory strain. The three elements of the levator ani - pubococcygeus, iliococcygeus and puborectalis, their attachments and extensions, were reconstructed from pubic symphysis to sacrum. Images were assessed for surface, shape, thickness and pressure. Pressure calculations were validated with a standard vaginal perineometer. A hyperelastic model of soft tissues was built using finite element analysis.

Results

Normals: The levator ani muscles were approximately symmetrical at rest, with thicknesses left and right within 1.2mm of each other. On squeeze and straining, the largest movement was around the anterior portion of pubococcygeus, with a maximal displacement of 30mm, and to a lesser extent at its medial aspects. Pressure change was most significant in the posterior aspect of the levator hiatus (20cm H_2O), corresponding to the apex of the puborectalis. The muscle surfaces of asymptomatic subjects were smooth and uniform throughout contraction and straining.

Obstructed Defecation (OD and Prolapse (PR): Preliminary results from patients with OD and PR showed asymmetry in shape and thickness. Muscle surfaces were irregular, especially around the levator hiatus and extending into the pelvis. In OD, greater biconvexity of the iliococcygeus was seen on straining at stool. This may indicate uncoordinated contraction or spasm of the levators against abdominal strain. The iliococcygeal angle was significantly increased in patients with PR, especially on straining.

Interpretation of results

Patients with obstructed defecation and significant prolapse have irregular, asymmetric pelvic floors, which may indicate altered contractility and function. Most of the strain of the levator ani was concentrated in the posterior aspect of the levator ani and hiatus (Figure 1). With the pattern of pressure demonstrated in this study, it is possible that chronic straining at stool may predispose to pudendal/levator nerve neuropathy to the anal sphincter. This effect would not affect the innervation to the anterior levator ani.

Concluding message

This new technique provides dynamic functional assessment of pelvic floor musculature and may be useful in individualizing patients' treatment strategies.

References

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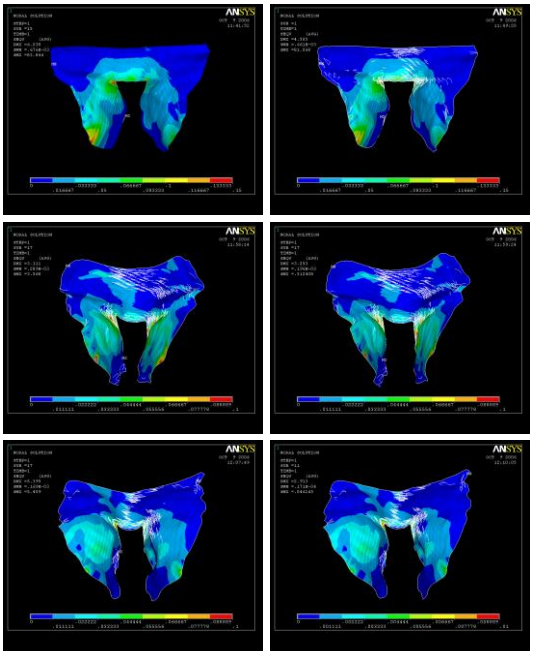

Figure 1. Example simulation results of the levator anis from three subjects, with contraction results on the left and strain results on the right. Light areas indicate areas of higher strain.

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Is this a clinical trial?	**No**
What were the subjects in the study?	**HUMAN**
Was this study approved by an ethics committee?	**Yes**
Specify Name of Ethics Committee	**St Mary's Local Research Ethics Committee**
Was the Declaration of Helsinki followed?	**Yes**
Was informed consent obtained from the patients?	**Yes**